

Biomining of regolith simulants for biological in situ resource utilization, Phase I

Completed Technology Project (2012 - 2013)



Project Introduction

The goal of this proposed research is to advance the development of biological in situ resource utilization for NASA's space exploration programs. We plan to build a foundation to use synthetic biology to engineer microorganisms to extract metals from naturally occurring extraterrestrial regolith. We propose to create a novel growth medium designed to mimic the lunar regolith ice discovered at the south pole of the moon by the LCROSS mission. We will develop a bioleaching column for this simulant to purify metals for consumable production in space. We will characterize known biomining organisms to leach this simulant. Finally we will study the biochemical processes taking place in the leaching of the regolith to be able to improve the metabolism of these organisms in the future. In addition, will produce a database of organisms involved in biomining on Earth and the geologies and substrates that they have been found on. This database can be used as a tool to find undersampled mine sites that may contain novel organisms suitable for biomining in space. We then plan to develop a conceptual bioreactor which is designed to extract metals from regolith in space. We will perform a trade study of the mass, productivity, cost and energy requirements of such a bioreactor. Later phases of the research will involve characterization of the important enzymes involved in biomining in key organisms, adding to the limited existing knowledge of these pathways and leading to creation of a synthetic biological system for efficiently engineering them, which we will use to optimize these organisms for extracting relevant substrates in relevant space-settlement-like conditions. This further research will also include growth on Mars-like simulant regoliths, as well as improvement of the bioreactor model in a series of increasingly durable and realistic prototypes that will undergo both physical and functional testing.



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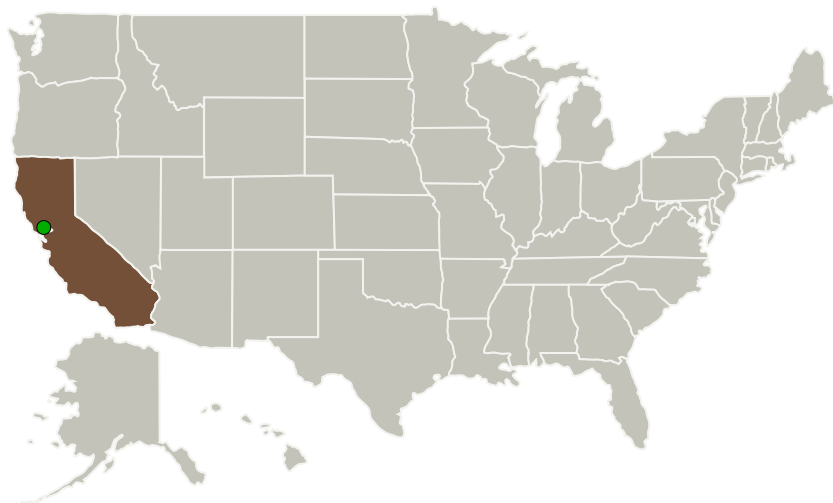
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Universal Bio Mining, LLC	Lead Organization	Industry	San Francisco, California
● Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California
SETI Institute(SETI)	Supporting Organization	Academia	Moffett Field, California

Primary U.S. Work Locations

California

Project Transitions

**February 2012:** Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Universal Bio Mining, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

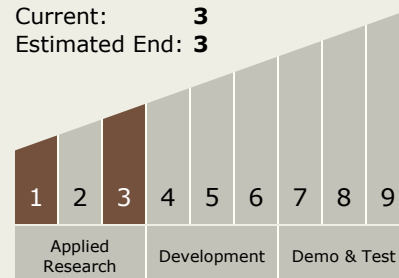
Carlos Torrez

Principal Investigator:

John R Cumbers

Technology Maturity (TRL)

Start: **1**
 Current: **3**
 Estimated End: **3**



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February 2013: Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/138020>)

Technology Areas

Primary:

- TX07 Exploration Destination Systems
 - └ TX07.1 In-Situ Resource Utilization
 - └ TX07.1.1 Destination Reconnaissance and Resource Assessment

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System